

CLAIMS

1. A process for recovering a target metal from an oxidised metalliferous material comprising the steps of:
  - in an acid generation stage, adding sulfuric acid to a solution comprising a metal halide to generate an acidic aqueous halide solution;
  - in a leaching stage that is separate to the acid generation stage, leaching the oxidised metalliferous material with the acidic aqueous halide solution to leach the target metal into solution;
  - passing the solution from the leaching stage to a target metal recovery stage in which the target metal is recovered from the solution whilst the metal halide is retained in solution; and
  - returning the solution with the metal halide therein from the target metal recovery stage to the acid generation stage.
2. A process as claimed in claim 1 wherein the metal of the metal halide solution is one that forms a precipitate with the sulfate anion of the sulfuric acid such that, with the generation of the acidic aqueous halide solution in the acid generation stage, a hydrohalous acid forms together with a precipitate of the metal sulfate.
3. A process as claimed in claim 2 wherein the metal of the metal halide solution is calcium so that the metal sulfate precipitate is calcium sulfate.
4. A process as claimed in any one of the preceding claims wherein the halide of the metal halide solution is chloride.
5. A process as claimed in any one of the preceding claims wherein, when the oxidised metalliferous material includes precious metal(s), the halide of the metal halide solution then comprises chloride and bromide.

Best Available Copy

6. A process as claimed in any one of the preceding claims wherein the acid generation stage is defined by a second leaching stage in which both acid generation, and secondary leaching of the oxidised metalliferous material 5 take place.

7. A process as claimed in claim 6 wherein the sulfuric acid is added directly to the second leaching stage.

8. A process as claimed in claim 7 wherein the metal of the metal halide solution is one that forms a precipitate 10 with the sulfate anion of the sulfuric acid such that the acidic aqueous halide solution generated is a hydrohalous acid, with a precipitate of the metal sulfate simultaneously forming and being removed with the second leached solids to be discarded as residue.

15 9. A process as claimed in any one of claims 1 to 5 wherein the leaching stage comprises first and second leaching stages that operate in a counter-current configuration, whereby:

- the oxidised metalliferous material is added to the 20 first leaching stage to contact the solution and leach target metal into solution; and
- the solution from the first leaching stage is separated from first leached solids and passed to the target metal recovery stage; and

25 - the first leached solids are passed to the second leaching stage to be mixed with the acidic aqueous halide solution generated in the acid generation stage; and

- the solution from the second leaching stage is separated from second leached solids and passed to the first 30 leaching stage, and the second leached solids are discarded as residue.

10. A process as claimed in claim 9 wherein a portion of the solution from the second leaching stage is not passed

Best Available Copy

to the first leaching stage but is diverted to the acid generation stage whereby, after the sulfuric acid is added to this solution, the acidic aqueous halide solution is then generated for feeding to the second leaching stage to 5 mix with the first leached solids.

11. A process as claimed in claim 9 or 10 wherein the metal of the metal halide solution is one that forms a precipitate with the sulfate anion of the sulfuric acid such that, the acidic aqueous halide solution generated in 10 the acid generation stage is a hydrohalous acid, and such that a precipitate of the metal with sulfate anion forms.

12. A process as claimed in claim 11 wherein, prior to passing the acidic aqueous halide solution to the second leaching stage, any precipitate of the metal formed with 15 the sulfate anion is removed.

13. A process as claimed in any one of the preceding claims wherein the target metal recovery stage comprises a precipitation stage in which a precipitate of the target metal is formed by adding a precipitation agent to the 20 solution.

14. A process as claimed in claim 13 wherein the precipitation agent can include a metal that is the metal of the metal halide solution, such that addition of the precipitation agent can maintain a desired concentration 25 of that metal in solution.

15. A process as claimed in claim 14 wherein, when the metal of the metal halide solution forms a precipitate with the sulfate anion and is removed in the acid generation stage, a corresponding amount of that metal is 30 added in the target metal recovery stage to maintain the desired concentration.

16. A process as claimed in any one of claims 13 to 15 wherein the oxidised metalliferous material comprises more

BEST AVAILABLE COPY

than one target metal, and a respective precipitation stage is provided for each target metal.

17. A process as claimed in any one of claims 13 to 16 wherein the oxidised metalliferous material includes iron, 5 whereby a proportion of that iron is leached into solution in the leaching stage, with at least a proportion of the leached iron then being precipitated in an iron precipitation stage as ferric oxide through the addition of calcium carbonate as the precipitation agent.

10 18. A process as claimed in claim 17 wherein the oxidised metalliferous material has sufficient residence time in the leaching stage such that leached iron can be oxidised through to haematite.

15 19. A process as claimed in any one of claims 13 to 18 wherein, when the target metal includes copper, the precious metal is precipitated in a copper precipitation stage by adding calcium carbonate as the precipitation agent.

20 20. A process as claimed in any one of claims 13 to 19 wherein, when the target metal includes a precious metal, the precious metal is precipitated in a precious metal precipitation stage by adding NaSH as the precipitation agent.

25 21. A process as claimed in any one of claims 13 to 20 wherein, when the target metal includes nickel and/or cobalt, the nickel and/or cobalt is precipitated in a nickel/cobalt precipitation stage by adding calcium hydroxide as the precipitation agent.

30 22. A process as claimed in any one of claims 13 to 21 wherein, when the target metal includes magnesium, the magnesium is precipitated in a magnesium precipitation stage by adding calcium hydroxide as the precipitation agent.

Useful Available Copy

23. A process as claimed in claim 21 or 22 wherein the calcium hydroxide is slaked lime.

24. A process as claimed in any one of claims 1 to 12 wherein the target metal recovery stage comprises an 5 electrolytic recovery stage, whereby the solution from the leaching stage is passed to one or more electrolysis cells for metal recovery by electro-deposition.

25. A process as claimed in claim 24 wherein the oxidised metalliferous material comprises more than one target 10 metal, and a respective electrolytic recovery stage is provided for each target metal.

26. A process as claimed in any one of the preceding claims wherein the sulfuric acid is added to the acid generation stage to achieve a pH in the range 0 to 1 and a 15 solution Eh of -600mV.

27. A process as claimed in any one of the preceding claims wherein the temperature of the solution in the leaching stage is in the range 85 - 95°C.

28. A process as claimed in any one of the preceding 20 claims wherein, when the halide is chloride, total chloride concentration is in the range of 6 to 8 M.

29. A process as claimed in any one of the preceding claims wherein, when the halide is chloride and the solution metal is calcium, at least 30g/l of  $\text{CaCl}_2$  is 25 maintained in the process solution.

30. A process for leaching a target metal from an oxidised metalliferous material, the process comprising first and second leaching stages in which an acidic aqueous halide solution generated from sulfuric acid and 30 used for leaching the target metal into solution passes counter-currently therethrough, wherein the acid generated from sulfuric acid is added to or formed in the second leaching stage, and the oxidised metalliferous material is

Best Available Copy

fed to the first leaching stage and contacted with a recycle of residual acid in solution from the second leaching stage to leach the material and produce first leached solids, and wherein the solution is separated from

5 the first leached solids and may be passed to target metal recovery, whereas the first leached solids are passed to the second leaching stage for contact with the acidic aqueous halide solution for further leaching of the solids whilst producing the residual acid recycle solution.

10 31. A process as claimed in claim 30 wherein the acid generated from sulfuric acid is generated in a separate stage from the second leaching stage prior to being added thereto, or is generated in the second leaching stage.

32. A process as claimed in claim 30 or 31 wherein the

15 oxidised metalliferous material includes iron such that a proportion of iron is leached into solution in the first leaching stage and precipitated as ferric oxide, with the ferric oxide precipitate passing with the solids to the second leaching stage.

20 33. A process as claimed in any one of claims 30 to 32 wherein the leaching process is otherwise as defined in any one of claims 1 to 29.

34. A target metal recovered by the process of any one of the preceding claims.

Best Available Copy